Conjunctive Management

Conjunctive management is the coordinated operation of surface water storage and use, groundwater storage and use, and conveyance facilities. Although surface water and groundwater are sometimes considered to be separate resources, they are connected by the hydrologic cycle. Streams can receive dry weather base flow from groundwater storage, and streams provide wet weather recharge to groundwater storage. Water quality of both resources and the environment can also be influenced by their interaction. Conjunctive management allows these two resources to be managed in an efficient manner by taking advantage of the ability of surface storage to capture and temporarily store storm water and the ability of aquifers to serve as long term storage.

A key aspect of conjunctive management projects is groundwater recharge. Groundwater recharge is the movement of surface water from the land surface, through the top soil and subsurface, and into empty aquifer space. Recharge occurs naturally from precipitation falling on the land surface, from water stored in lakes, and from creeks and rivers carrying storm runoff. Recharge also occurs artificially from water placed into constructed recharge ponds (also called spreading basins), from water injected into the subsurface by wells, and from surface storage releases into creeks and rivers beyond what occurs from the natural hydrology (for example, by releases of imported water). Significant amounts of artificial recharge can also occur either intentionally or incidentally from applied irrigation water and from water placed into unlined conveyance facilities. Groundwater banking is the recharge (often of imported surface water, or local flood water) into empty groundwater storage space for later recovery and use or exchange with others.

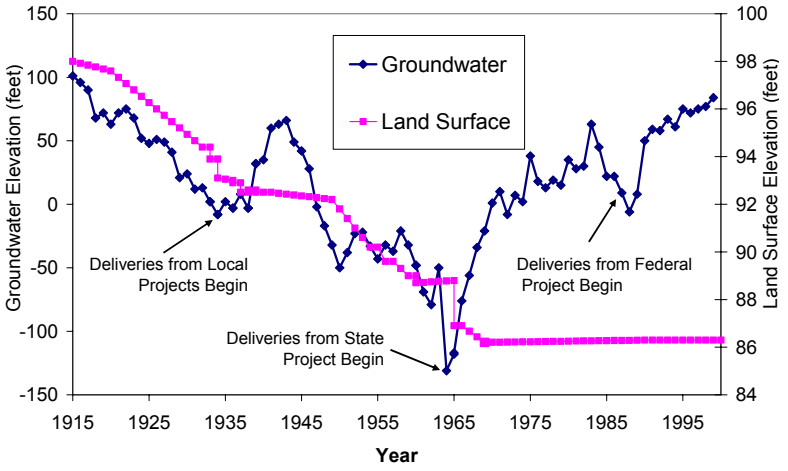
Conjunctive management is implemented to meet resource management objectives. For example, to improve water supply reliability, to reduce groundwater overdraft and land subsidence, to protect water quality, and more recently to improve environmental conditions. There are three primary components to a conjunctive management project. The first is to recharge groundwater when surface water is available to increase groundwater storage. In some areas this is accomplished by reducing groundwater use and substituting it with surface water, allowing natural recharge to increase groundwater storage (also called in-lieu recharge). The second component is to switch to groundwater use in dry years when surface water is scarce. The third component is to have an ongoing monitoring program to evaluate and allow water managers to respond to changes in groundwater, surface water, or environmental conditions that could violate management objectives or impact other water users. Together these components make up the conjunctive management project.

Current Conjunctive Management in California

Conjunctive management has been practiced in California to varying degrees since the Spanish mission era. The first known artificial recharge of groundwater in California occurred in Southern California during the late 1800's and is now used as a management tool in many areas. Since surface and groundwater management are closely linked, it is difficult to separate specific benefits of each. Two examples illustrate the types of conjunctive management underway on a regional and local scale. In Southern California, including Kern County, conjunctive management has increased average year water deliveries by over 2 million acre-feet (AGWA, 2000). Over a period of years, artificial recharge in these areas has increased the water currently in groundwater storage by approximately 7 million acre-feet.

Santa Clara Valley Water District releases local supplies and imported water into more than 20 local creeks for artificial instream recharge and into more than 70 recharge ponds to recharge a total of about 157 thousand acre-feet annually. Conjunctive management has virtually stopped land subsidence caused by heavy groundwater use and has allowed groundwater levels to recover to those of the early 1900s (see Figure 1).

Figure 1. Relationship between Groundwater Elevations and Land Subsidence in Santa Clara County



While comprehensive statewide data on conjunctive management is not available, DWR's Conjunctive Water Management Program provides an indication of the types and magnitude of projects that water agencies are currently pursuing. The program has awarded over $130 Million in grants and loans for project funding and study throughout California in fiscal years 2001 and 2002 (see Figure 2).

Potential Benefits from Conjunctive Management

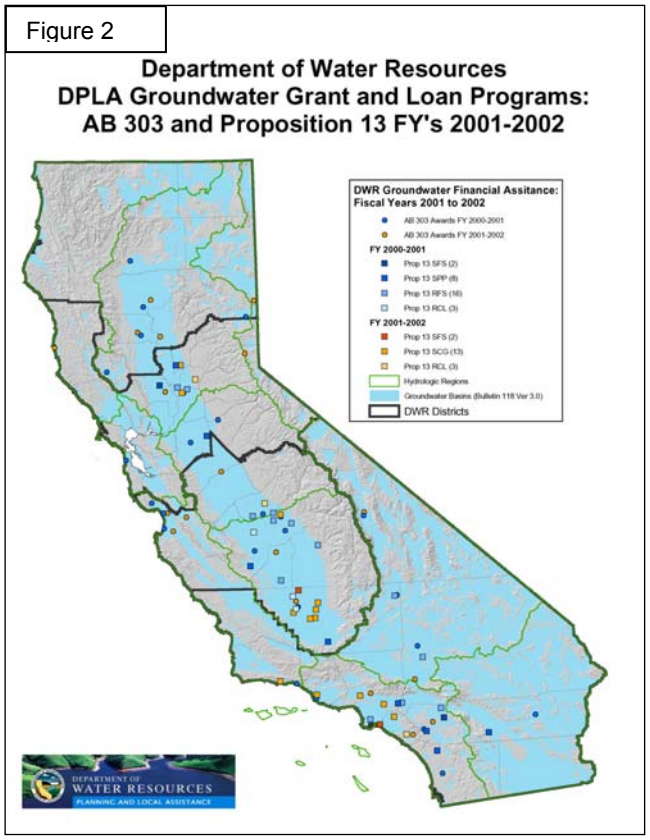
Conservative estimates[1] from additional conjunctive management indicate the potential to increase average annual water deliveries throughout the State by 500 thousand acre-feet with about 9 million acre-feet of "new" groundwater storage.

[1] Information in this section was derived from five sources: 1) Proposition 13 Groundwater Storage Applications to DWR for fiscal year 2001-2002, 2) A 2000 report by the Association of Groundwater Agencies entitled, "Groundwater and Surface Water in Southern California", 3) A 1998 report by the Natural Heritage Institute entitled, "Feasibility Study of a Maximal Program of Groundwater Banking", 4) A 2002 report by the Natural Heritage Institute entitled, "Estimating the Potential for In-Lieu Conjunctive Management in the Central Valley", 5) A 2002 report by the U.S. Army Corps of Engineers report entitled, "Conjunctive Use for Flood Protection". Methodology for obtaining these estimates is presented in Volume 4.

New storage includes both reoperation of existing groundwater storage and recharging water into currently empty groundwater storage space. More aggressive estimates from screening level studies indicate the potential to increase average annual water deliveries by 2 million acre-feet with about 20 million acre-feet of new storage.

The potential benefits from additional conjunctive management are highly dependent on adequate water quality and the ability to capture, convey, and recharge surface water. The above estimates are based on increases in local water deliveries from individual projects only and do not necessarily reflect a statewide increase in supply reliability. An increase in statewide supply reliability only occurs when the individual projects utilize water that would otherwise not be used by other water users or the environment. The more aggressive estimates are based on assumptions that require major reoperation of existing surface water reservoirs and groundwater storage to achieve the benefits and do not fully consider the conveyance capacity constraints for exports from the Delta and other conveyance facilities.

Figure 2



In addition to water supply benefits, conjunctive management can provide environmental benefits when recharge basins are designed to be compatible with wildlife habitat, such as utilizing natural floodplains and wetlands as recharge areas. Re-operation of surface water storage and use conjunctively with groundwater storage and use can avoid impacts to aquatic species by allowing better management of instream flow and water quality conditions.

Potential Costs of Conjunctive Management

Grant applications from DWR's fiscal year 2001-2002 Conjunctive Water Management Program show project costs ranging from $10 to $600 per acre-foot of increase in average annual delivery. The wide range of costs is due to many factors including project complexity, regional differences in construction costs, availability and quality of recharge supply, intended use of water, and treatment requirements. In general, urban uses can support higher project costs than agricultural uses. The average project cost of all applications received by DWR is $110 per acre-foot of increase in average annual delivery. This average project cost is a weighted

average, which weights each project by the relative increase in water deliveries. While these cost estimates are specific to projects evaluated by DWR, they provide a good indication of implementation costs Statewide. This translates to total implementation costs of approximately $1.3 billion for the more conservative level of implementation. The cost of implementing the more aggressive level of conjunctive management are unknown.

Major Issues Facing Additional Conjunctive Management

Lack of Data – Data is needed to evaluate conditions and trends laterally over an area, vertically at different depths, and over time. There is rarely a complete regional network to monitor groundwater levels, water quality, land subsidence, or the interaction of groundwater with surface water and the environment. Also, there is often a reluctance of individuals who own groundwater monitoring or supply wells to provide information or allow access to collect additional information. The result is that decisions must be made with only approximate knowledge of the "true" system. This uncertainty can make any change in operation of groundwater storage unpredictable and controversial.

Infrastructure Needs – The physical capacity of existing storage and conveyance facilities are often not large enough to capture surface water when it is available in wet years. For example, when there is surface water available for export from the Delta, export facilities are already pumping at full capacity and additional water cannot be moved to groundwater banks south of the Delta. Expanding existing or developing new storage or conveyance infrastructure can increase the flexibility and ability to conduct conjunctive management projects. It is also possible to reoperate the existing system to increase the benefits of conjunctive management.

Interconnection between Surface Water and Groundwater – In California, water management practices and the water rights system treat surface water and groundwater as two unconnected resources. In reality, there is often a high degree of hydrologic connection between the two. Under predevelopment conditions many streams received dry weather base flow from groundwater storage, and streams provided wet weather recharge to groundwater storage. Water quality and the environment can also be influenced by the interaction between surface water and groundwater. Failure to understand these connections can lead to unintended impacts. For example, pumping more groundwater than is recharged over the long term has reduced or eliminated dry year base flow in some streams, which can reduce the water available to other water users and the environment.

Water Quality – The flexibility of conjunctive management projects is influenced by the quality of both the recharge water and the receiving groundwater as well as the intended end use for the water. Groundwater quality can be degraded by low quality recharge water, naturally occurring or human introduced chemical constituents, or chemical reactions caused by mixing water of differing qualities. Protection of

human health, the environment, and groundwater quality is a concern for programs that recharge urban runoff or reclaimed/ recycled water. The intended end use of the water can also influence the implementation of conjunctive management projects. For example, agriculture can generally use water of lower quality than needed for urban use, but certain crops can be sensitive to some constituents like boron. New and changing water quality standards and emerging contaminants add uncertainty to implementing conjunctive management projects.

Environmental Concerns – Environmental concerns related to conjunctive management projects include potential impacts on habitat, water quality, and wildlife caused by shifting or increasing patterns of groundwater and surface water use. For example, flood waters are typically considered "available" for recharge. However, flood flows serve an important function in the ecosystem, and removing or reducing these peak flows can negatively impact the ecosystem. A key challenge is to balance the instream flow and other environmental needs with the water supply aspects of conjunctive management projects. There may also be impacts from construction and operation of groundwater recharge basins and new conveyance facilities.

Funding – There is generally limited financing to develop the infrastructure and monitoring capability to fully implement and monitor conjunctive management projects. This includes funding to develop and implement groundwater management plans, to study and construct conjunctive management projects, and to track, both Statewide and regionally, changes in groundwater levels, groundwater flows, groundwater quality (including the location/spreading of contaminant plumes), land subsidence, changes in surface water flow, surface water quality, and the interaction and interrelated nature of surface water and groundwater.

Lack of Integrated Management of Water Resources – In California, authority is separated among local, State and federal agencies for managing different aspects of groundwater and surface water resources. Several examples highlight this issue: 1) SWRCB regulates surface water rights dating from 1914, but not rights dating before 1914; 2) SWRCB also regulates groundwater quality, but not the rights to use groundwater; 3) Ordinances adopted by counties to protect groundwater resources only apply to the portion of the groundwater basin they overlie and may conflict with water districts that have their own groundwater management plan. 4) Except in adjudicated basins, individuals have few restrictions on how much groundwater they can use, provided the water is put to beneficial use on the overlying property. Failure to integrate water management across jurisdictions makes it difficult to manage water for multiple benefits and provide for sustainable use including the ability to identify and protect or mitigate potential impacts to third parties, ensure protection of legal rights of water users, establish rights to use vacant aquifer space and banked water, protect the environment, recognize and protect groundwater recharge and discharge areas, and protect public trust resources.

Recommendations to Help Promote Additional Conjunctive Management

1. Continue funding for local groundwater monitoring and management activities, feasibility studies, and construction of facilities that enhance the coordinated use of groundwater and surface water. Additional monitoring and analysis is needed to track, both Statewide and regionally, changes in groundwater levels, groundwater flows, groundwater quality (including the location/spreading of contaminant plumes), land subsidence, changes in surface water flow, surface water quality, and the interaction and interrelated nature of surface water and groundwater. There is a need to develop comprehensive data on existing, proposed, and potential conjunctive management projects throughout the state and identify and evaluate regional and statewide implementation constraints including availability of water to recharge, ability to convey water from source to destination, water quality issues, environmental issues, and costs and benefits.

2. Give priority for funding and technical assistance to conjunctive management projects that are conducted in accordance with a groundwater management plan, increase water supplies, and have other benefits including the sustainable use of groundwater, maintaining or improving water quality, and enhancing the environment. In addition, allow funding for projects that make use of wet season / dry season supply variability, not just wet year / dry year variability.

3. Encourage the development of regional groundwater management plans. A 'regional plan' has no specific definition. However, local water management agencies should coordinate with other agencies that are involved in activities that might affect long term sustainability of water supply and water quality within the basin or adjacent to the basin. Such regional coordination will take different forms in each area because of dissimilar political, legal, institutional, technical, and economic constraints and opportunities. Regional groundwater management plans should be developed with assistance from an advisory committee of stakeholders to help guide the development, educational outreach, and implementation of the plans.

4. Assess groundwater management throughout the State to provide an understanding of how local agencies are implementing actions to use and protect groundwater, an understanding of which actions are working at the local level and which are not working, and how State programs can be improved to help agencies prepare effective groundwater management plans.

5. Improve coordination and cooperation among local, State, and federal agencies with differing responsibilities for groundwater and surface water management and monitoring to facilitate conjunctive management, to ensure efficient use of resources, to provide timely regulatory approvals, to prevent conflicting rules or guidelines, and to promote easy access to information by the public.

6. Encourage local groundwater management authorities to manage the use of vacant aquifer space for artificial recharge.

7. Encourage the development of multi-benefit projects that generate source water for groundwater storage by capturing water that would otherwise not be used by other water users or the environment. For example through reservoir reoperation, water recycling and reuse, and water conservation.

8. Work with wildlife agencies to streamline the environmental permitting process for the development of conjunctive management facilities, like recharge basins, when they are designed with pre-defined benefits or mitigation to wildlife and wildlife habitat.

Information Sources

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